UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P O Box 1450
Alexandria, Virginia 22313-1450
www uspto gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/518,453	07/12/2005	Martine Mayne	BRV.10035	7851

45473 7590 04/11/2008
HUTCHISON LAW GROUP PLLC
PO BOX 31686
RALEIGH, NC 27612

EXAMINER	
MCCRACKEN, DANIEL	
ART UNIT	PAPER NUMBER
1793	
MAIL DATE	DELIVERY MODE
04/11/2008	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/518,453	MAYNE ET AL.	
	Examiner	**Art Unit**	
	DANIEL C. MCCRACKEN	1793	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *18 August 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-44* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-44* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *8/18/2005*.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application

6) ☐ Other: _____.

DETAILED ACTION

Citation to the Specification will be in the following format (S. # : ¶) where # denotes the page number and ¶ denotes the paragraph number. Citation to patent literature will be in the form (Inventor # : LL) where # is the column number and LL is the line number. Citation to the pre-grant publication literature will be in the following format (Inventor # : ¶) where # denotes the page number and ¶ denotes the paragraph number.

Information Disclosure Statement

The listing of references in the specification is not a proper information disclosure statement. 37 CFR 1.98(b) requires a list of all patents, publications, or other information submitted for consideration by the Office, and MPEP § 609.04(a) states, "the list may not be incorporated into the specification but must be submitted in a separate paper." Therefore, to the extent the listing in the specification varies from the IDS, and unless the references have been cited by the examiner on form PTO-892, they have not been considered.

The Examiner has considered the relevance of all foreign patent documents insofar as the translated abstract indicates. "The duty of candor does not require that the applicant translate every foreign reference, but only that the applicant refrain from submitting partial translations and concise explanations that it knows will misdirect the examiner's attention from the reference's relevant teaching." *Semiconductor Energy Laboratory Co. v. Samsung Electronics Co.*, 204 F.3d 1368, 1378, 54 USPQ2d 1001 1008 (Fed. Cir. 2000).

Certain references listed on the IDS (e.g. the Andrews & Mayne reference) were missing pages. They were crossed off on the IDS to reflect this. If Applicants want them considered,

complete copies should be supplied. However, if they were applied in an art rejection *infra*, they need not be submitted.

Remarks

Applicants preliminary amendment dated 12/20/2004 has been received and will be entered.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 2-3 and 30 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

The "continuous or periodic automobile heat engine injector type" limitation of Claim 2-3 is indefinite. What does this mean? The "guidance" provided in the specification is little more than a recitation of the claim language itself. *See e.g.* (S. 6: 23-31). Would an injection system from a bus work? What about the injection system for the motor on a speedboat? How about the injection system in a carbon black reactor – is this of the same type? As to Claim 30, the "for example" language does not limit the clams at all.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

The entire reference teaches each and every limitation of the rejected claims. The pinpoint citations provided are in no way to be construed as limitations of the teachings of the reference, but rather illustrative of particular instances where the teachings may be found.

Claims 1-5, 8 10-12, 16-23, 28-31 and 43-44 are rejected under 35 U.S.C. 102(b) as being anticipated by Mayne, et al., *Pyrolytic production of aligned carbon nanotubes from homogeneously dispersed benzene-based aerosols*, Chemical Physics Letters 2001; 338: 101-107 (hereinafter "Mayne at __").

With respect to Claim 1, Mayne teaches a process for making nanotubes by pyrolyzing a liquid hydrocarbon precursor. *See generally* (Mayne at 102) ("2. Experimental"). Note the "atomizer" (i.e. the "injection system"). The argon would appear to be the "carrier gas." *Id.* As to the "optionally" language ("optionally at least one metal compound precursor"), this is not per se indefinite - *see* MPEP 2173.05(h) (III. "Optionally") – but regardless, Mayne teaches ferrocene. (Mayne at 102, col. 2). Ferrocene also addresses Claims 10-12 and 16-17. As to Claims 18-19, Mayne teaches a 2.5% ferrocene solution. (Mayne at 102, col. 1, "Fig. 2," caption). As to Claims 2-3, Mayne recites a continuous injector system that appears to have a needle valve. (Mayne at 102, "Fig. 1"). As to Claim 4, the nanotubes are aligned and substantially perpendicular. (Mayne "Abstract; 103; "Fig 2"). As to Claim 5, the lengths are taught. (Mayne at 103, col. 2; "Fig 2"). As to Claim 8, Mayne teaches benzene (6 carbons, aromatic). (Mayne at 102). According to the claim, it doesn't have to be substituted. As to Claims 20-22, Mayne teaches benzene and

ferrocene together as claimed and disclosed by Applicants. (Mayne at 102, "2. Experiemntal," "Fig. 1"). To the extent Mayne may not recite *in haec verba* that a colloidal suspension is formed, it is expected necessarily be taught by Mayne owing to the same reagents claimed being taught and used. This is the evidence offered to show inherency. "[T]he PTO can require an applicant to prove that the prior art products do not necessarily or inherently possess the characteristics of his [or her] claimed product. Whether the rejection is based on inherency' under 35 U.S.C. 102, on prima facie obviousness' under 35 U.S.C. 103, jointly or alternatively, the burden of proof is the same...[footnote omitted]." The burden of proof is similar to that required with respect to product-by-process claims. *In re Fitzgerald*, 619 F.2d 67, 70, 205 USPQ 594, 596 (CCPA 1980) (quoting *In re Best*, 562 F.2d 1252, 1255, 195 USPQ 430, 433-34 (CCPA 1977)). As to Claim 23, given the "atomization" recited, it is expected that the liquid particles have the claimed dimensions. (Mayne at 102). See above with respect to inherency and burden shifting. As to Claim 28, the temperatures are taught. (Mayne at 102, col. 2). As to Claim 29, a time of 15 minutes is taught. *Id.* As to Claim 30, low pressure is taught. (Mayne at 102, col. 1). As to Claim 31, the product is deposited on the walls. (Mayne at 102, col 1).

With respect to Claims 43-44, Mayne teaches a reaction chamber and the means for forming finely divided liquid particles that are connected to the evaporation device. The connection ring (which is being interpreted as any ring shaped connection) is reasonably taught. *See* (Mayne at 102 "Experimental," "Fig. 1").

Claims 1-5, 8, 10-12, 15-17, 20-23, 28-31, and 43-44 are rejected under 35 U.S.C. 102(b) as being anticipated by Kamalakaran, et al., *Synthesis of thick and crystalline nanotube arrays by spray pyrolysis*, Applied Physics Letters 2000; 77(21): 3385-3387 (hereinafter "Kamalakaran at __").

With respect to Claim 1, Kamalakaran recites pyrolysis of a liquid hydrocarbon precursor (benzene) with a metal compound precursor (ferrocene) by employing an atomizing spray nozzle. (Kamalakaran at 3385). As to Claims 2-3, Kamalakaran teaches a continuous injection system that appears to have a needle valve. (Kamalakaran at 3385, "Fig. 1"). As to Claim 4, the nanotubes appear to be arranged as claimed. (Kamalakaran "Fig. 2"). As to Claim 5, the lengths are taught. *Id.* As to Claim 8, benzene is taught. (Kamalakaran at 3385, col. 1). As to Claims 10-12 and 15-17, ferrocene is taught. *Id.* As to Claims 20-22, Kamalakaran teaches benzene and ferrocene together as claimed and disclosed by Applicants. *Id.* To the extent Mayne may not recite *in haec verba* that a colloidal suspension is formed, it is expected necessarily be taught by Mayne owing to the same reagents claimed being taught and used. This is the evidence offered to show inherency. "[T]he PTO can require an applicant to prove that the prior art products do not necessarily or inherently possess the characteristics of his [or her] claimed product. Whether the rejection is based on inherency' under 35 U.S.C. 102, on prima facie obviousness' under 35 U.S.C. 103, jointly or alternatively, the burden of proof is the same...[footnote omitted]." The burden of proof is similar to that required with respect to product-by-process claims. *In re Fitzgerald*, 619 F.2d 67, 70, 205 USPQ 594, 596 (CCPA 1980) (quoting *In re Best*, 562 F.2d 1252, 1255, 195 USPQ 430, 433-34 (CCPA 1977)). As to Claim 23, given the "atomization" recited, it is expected that the liquid particles have the claimed dimensions. (Kamalakaran at 3385, col. 2). As to Claim 28, the temperatures are taught. (Kamalakaran at 3385, col. 2). As to Claim 29, the times are taught. *Id.* As to Claim 30, notwithstanding the ambiguities noted above, there is necessarily a pressure recited by Kamalakaran. As to Claim 31, soot (containing nanotubes) were deposited on the walls of the reactor. (Kamalakaran at 3385, col. 2).

With respect to Claims 43-44, Kamalakaran discloses a reaction chamber, means for forming an aerosol, an injection system, and a connection ring. The connection ring (which is being interpreted as any ring shaped connection) is reasonably taught. (Kamalakaran at 3385, "Fig. 1").

Claims 1-5, 9-12, 15-17, 20-22, 27-31, and 43-44 are rejected under 35 U.S.C. 102(b) as being anticipated by Terrones, et al., *Novel nanoscale gas containers: encapsulation of N_2 in CN_x nanotubes*, Chem. Commun. 2000: 2335-2336 (hereinafter "Terrones at __").

With respect to Claim 1, Terrones teaches pyrolysis with an amine precursor and catalyst. (Terrones at 2335). Spray pyrolysis is taught. *Id.* As to Claims 2-3 a continuous injection tystem is recited. *Id.* As to Claim 4-5, the nanotubes are taught. (Terrones at 2335, "Fig. 1"). As to Claim 9, benzylamine is taught. (Terrones at 2335). As to Claims 10-12 and 15-17, ferrocene is taught. *Id.* Claims 20-22, Terrones teaches benzylamine and ferrocene together as claimed and disclosed by Applicants. *Id.* To the extent Mayne may not recite *in haec verba* that a colloidal suspension is formed, it is expected necessarily be taught by Mayne owing to the same reagents claimed being taught and used. This is the evidence offered to show inherency. "[T]he PTO can require an applicant to prove that the prior art products do not necessarily or inherently possess the characteristics of his [or her] claimed product. Whether the rejection is based on inherency' under 35 U.S.C. 102, on prima facie obviousness' under 35 U.S.C. 103, jointly or alternatively, the burden of proof is the same...[footnote omitted]." The burden of proof is similar to that required with respect to product-by-process claims. *In re Fitzgerald*, 619 F.2d 67, 70, 205 USPQ 594, 596 (CCPA 1980) (quoting *In re Best*, 562 F.2d 1252, 1255, 195 USPQ 430, 433-34 (CCPA

1977)). As to Claim 23, given the spray process recited, it is expected that the liquid particles have the claimed dimensions. (Terrones at 2335). As to Claim 27, the droplets necessarily evaporate. As to Claim 28, the temperatures are taught. *Id.* As to Claim 29, the times are taught. *Id.* As to Claim 30, notwithstanding the ambiguities noted above, there is necessarily a pressure recited by Terrones. As to Claim 31, the nanotubes are taught. (Terrones "Fig. 1").

With respect to Claims 43-44, Terrones recites a reaction chamber, means for forming an aerosol, an injection system, and a connection ring. The connection ring (which is being interpreted as any ring shaped connection) is reasonably taught. (Terrones at 2335, col. 1).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* v. *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various

claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

The references cited teach each and every limitation of the rejected claims. The pinpoint citations provided are in no way to be construed as limitations of the teachings of the reference, but rather illustrative of particular instances where the teachings may be found. As to the rejection under 35 U.S.C. §§ 102/103, where the applicant claims a composition in terms of a function, property or characteristic and the composition of the prior art is the same as that of the claim but the function is not explicitly disclosed by the reference, the Examiner may make a rejection under both 35 U.S.C. 102 and 103, expressed as a 102/103 rejection. *See* MPEP 2112 III. (discussing 102/103 rejections).

Claims 1-5, 8, 10-12, 16-23, 28-31 and 43-44 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Mayne, et al., *Pyrolytic production of aligned carbon nanotubes from homogeneously dispersed benzene-based aerosols*, Chemical Physics Letters 2001; 338: 101-107.

The preceding discussion accompanying the anticipation rejection over Mayne is expressly incorporated herein by reference. See above with respect to 102/103 rejections.

Claims 1-8, 10-12, 16-23, 28-31 and 43-44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Mayne, et al., *Pyrolytic production of aligned carbon nanotubes from*

homogeneously dispersed benzene-based aerosols, Chemical Physics Letters 2001; 338: 101-107 as applied to claim 1 above, and further in view of Zhu, et al., *Direct Synthesis of Long Single-Walled Carbon Nanotube Strands*, Science 2002; 296: 284: 884-886.

The preceding discussion accompanying the anticipation rejection over Mayne is expressly incorporated herein by reference. To the extent Mayne may not teach non-aromatics (i.e. alkanes) as a hydrocarbon source, Zhu teaches hexane (i.e. a 6 carbon alkane). (Zhu at 884, col. 1). Zhu uses hexane to grown nanotubes, i.e. they are art recognized equivalents. Substitution of one for the other does not impart patentability.

Claims 1-8, 10-12, 16-23, 28-31 and 43-44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Mayne, et al., *Pyrolytic production of aligned carbon nanotubes from homogeneously dispersed benzene-based aerosols*, Chemical Physics Letters 2001; 338: 101-107 as applied to claim 1 above, and further in view of Ci, et al., *Preparation of carbon nanotubules by the floating catalyst method*, J. Mater. Sci. Ltrs. 1999; 18: 797-799 (hereinafter "Ci at __").

The preceding discussion accompanying the anticipation rejection over Mayne is expressly incorporated herein by reference. To the extent Mayne may not teach non-aromatics (i.e. alkanes) as a hydrocarbon source, Ci teaches hexane (i.e. a 6 carbon alkane). (Ci at 797, col. 2). Ci uses hexane to grown nanotubes, i.e. they are art recognized equivalents. Substitution of one for the other does not impart patentability. Furthermore, Ci provides motivation to use hexane, for example the ability to "dissolve a catalyst (i.e., ferrocene) quite easily." *Id.*

Claims 1-5, 8, 10-23, 28-31 and 43-44 rejected under 35 U.S.C. 103(a) as being unpatentable over Mayne, et al., *Pyrolytic production of aligned carbon nanotubes from homogeneously dispersed benzene-based aerosols*, Chemical Physics Letters 2001; 338: 101-107 as applied to claim 1 above, and further in view of Cassell, et al., *Large Scale CVD Synthesis of Single-Walled Carbon Nanotubes*, J. Phys. Chem. B 1999; 103: 6484-6492 (hereinafter "Cassell at __").

The preceding discussion accompanying the anticipation rejection over Mayne is expressly incorporated herein by reference. To the extent Mayne may not teach metal salts as a catalyst, the Examiner is taking official notice that the use of metal salts in nanotube synthesis is old and known. In support of taking official notice (i.e. in making sure there is substantial evidence on the record), the Examiner cites to Cassell. *See generally* (Cassell at 6485, col. 1) ("Catalyst Preparation"). Note that with respect to Claims 12-14, iron and nitrates are taught. *Id.* One would be motivated to employ metal salts as they afford the skilled artisan the ability to optimize the chemical composition of the catalyst, as taught and suggested by Cassell. (Cassell at 6492, col. 1).

Claims 1-5, 8, 10-12, 16-31 and 43-44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Mayne, et al., *Pyrolytic production of aligned carbon nanotubes from homogeneously dispersed benzene-based aerosols*, Chemical Physics Letters 2001; 338: 101-107 as applied to claim 1 above, and further in view of US 5,697,432 to Anderson, et al.

The preceding discussion accompanying the anticipation rejection over Mayne is expressly incorporated herein by reference. To the extent Mayne may not teach the "specific

injection system" as claimed in claims 2-3, 24-26 and 43-44, Anderson discloses an injection system of the "automobile heat engine" type. *See* (Anderson 1: 59 *et seq.*). Note that Anderson recites a "needle valve." (Anderson "Abstract"). Mayne teaches that homogeneity within the reactor is desirable. (Mayne at 102, col. 1). Anderson discloses the ability to vary the amount of fuel and the time interval between injection, *i.e.* controlling homogeneity of the amount of fuel injected. *See generally* (Anderson 14: 5 *et seq.*). One would be motivated to use the injection system of Anderson with the process of Mayne due to the ability to control the amount of fuel/precursor introduced into the reactor.

Claims 1-5, 8, 10-12, 16-23, 27-31 and 43-44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Mayne, et al., *Pyrolytic production of aligned carbon nanotubes from homogeneously dispersed benzene-based aerosols*, Chemical Physics Letters 2001; 338: 101-107 as applied to claim 1 above, and further in view of WO 00/63115 to Dai, et al.

The preceding discussion accompanying the anticipation rejection over Mayne is expressly incorporated herein by reference. To the extent Mayne may not teach the two stage heating (evaporation followed by introduction into the reactor) as required by Claim 27, Dai does. *See* (Dai "Fig. 1"). Employing the two stage process of Dai would allowed the skilled artisan to "control the conditions of pyrolysis to obtain nanotubes having the desired characteristics. (Dai 4: 14).

Claims 1-5, 8, 10-12, 16-23, and 28-44 rejected under 35 U.S.C. 103(a) as being unpatentable over Mayne, et al., *Pyrolytic production of aligned carbon nanotubes from*

homogeneously dispersed benzene-based aerosols, Chemical Physics Letters 2001; 338: 101-107 as applied to claim 1 above, and further in view of Li, et al., Structure and growth of aligned carbon nanotube films by pyrolysis, Chemical Physics Letters 2000; 316: 349-355 (hereinafter "Li, CPL at __"), Li, et al., Large-Scale Synthesis of Aligned Carbon Nanotubes, Science 1996; 274: 1701-1703 (hereinafter "Li, Science at __"), Smiljanic, et al., Growth of carbon nanotubes on Ohmically heated carbon paper, Chemical Physics Letters 2001; 342: 503-509 (hereinafter "Smiljanic at __"), and Zheng, et al., *Chemical Vapor Deposition Growth of Well-Aligned Carbon Nanotube Pattens on Cubic Mesoporous Silica Films by Soft Lithography*, Chem. Mater. 2001; 13: 2240-2242 (hereinafter "Zheng at __").

The preceding discussion accompanying the anticipation rejection over Mayne is expressly incorporated herein by reference. With respect to Claims 32-42, to the extent Mayne may not recite a substrate, the Examiner is taking official notice that growing nanotubes on a variety of substrates with a catalyst is old and known. In fact, it is quite common. In support of taking official notice (i.e. in making sure there is substantial evidence on the record), the Examiner provides the following (with the caveat that *many more* references teaching a nanotube on a substrate could have been provided):

1. Li, et al., *Structure and growth of aligned carbon nanotube films by pyrolysis*, Chemical Physics Letters 2000; 316: 349-355.

2. Li, et al., *Large-Scale Synthesis of Aligned Carbon Nanotubes*, Science 1996; 274: 1701-1703.

3. Smiljanic, et al., *Growth of carbon nanotubes on Ohmically heated carbon paper*, Chemical Physics Letters 2001; 342: 503-509.

4. Zheng, et al., *Chemical Vapor Deposition Growth of Well-Aligned Carbon Nanotube Pattens on Cubic Mesoporous Silica Films by Soft Lithography*, Chem. Mater. 2001; 13: 2240-2242.

Note that Li – like Applicants - employs a pyrolysis technique. (Li, CPL at 350, col. 1). Also, note that Li employs quartz substrates, as claimed by Applicants. *Id.* To the extent that Li, CPL teaches introduction of the catalyst via a precursor (in the case of Li, iron (II) phthalocyanine) versus depositing the catalyst on a substrate – as claimed in Claim 33 - this embodiment is similarly old and known. Since at least the mid-1990s, skilled artisans have been depositing catalyst on substrates and growing nantoubes, *See* (Li, Science at 1702, col. 2; "Fig. 4"). Likewise, with respect to Claims 36 and 42 growing nanotubes on carbon fiber substrates is old an known. *See* (Smiljanic "Abstract"). (Note that claims 36 and 42 would read on nanotubes growing on top of other nanotubes in any nanotube growth process). The manner in which the catalyst can be deposited (Claims 37-41) is old and known, taught any number of places. For example, Zheng employs techniques to pattern catalysts on silica substrates. *See* (Zheng at 2241, "Figs. 1-2").

In sum, growing nanotubes with a catalyst on a substrate is hardly novel. One would be motivated to utilize a catalyst for any number of reasons – like the ability to place catalysts (and in turn nanotubes) in discrete locations with some precision as demonstrated by Zheng. Furthermore, employing a catalyst and substrate "shows fascinating possiblities for directed growth of CNTs that could be used for large area, low-cost, flexible electronic and photonic devices." (Zheng at 2242).

Claims 1-5, 8, 10-12, 15-17, 20-23, 28-31, and 43-44 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Kamalakaran, et

al., *Synthesis of thick and crystalline nanotube arrays by spray pyrolysis*, Applied Physics Letters 2000; 77(21): 3385-3387.

The preceding discussion accompanying the anticipation rejection over Kamalakaran is expressly incorporated herein by reference. See above with respect to 102/103 rejections.

Claims 1-8, 10-12, 15-17, 20-23, 28-31, and 43-44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kamalakaran, et al., *Synthesis of thick and crystalline nanotube arrays by spray pyrolysis*, Applied Physics Letters 2000; 77(21): 3385-3387 as applied to claim 1 above, and further in view of Zhu, et al., *Direct Synthesis of Long Single-Walled Carbon Nanotube Strands*, Science 2002; 296: 284: 884-886.

The preceding discussion accompanying the anticipation rejection over Mayne is expressly incorporated herein by reference. To the extent Kamalakaran may not teach non-aromatics (i.e. alkanes) as a hydrocarbon source, Zhu teaches hexane (i.e. a 6 carbon alkane). (Zhu at 884, col. 1). Zhu uses hexane to grown nanotubes, i.e. they are art recognized equivalents. Substitution of one for the other does not impart patentability.

Claims 1-8, 10-12, 15-17, 20-23, 28-31, and 43-44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kamalakaran, et al., *Synthesis of thick and crystalline nanotube arrays by spray pyrolysis*, Applied Physics Letters 2000; 77(21): 3385-3387 as applied to claim 1 above, and further in view of Ci, et al., *Preparation of carbon nanotubules by the floating catalyst method*, J. Mater. Sci. Ltrs. 1999; 18: 797-799.

The preceding discussion accompanying the anticipation rejection over Kamalakaran is expressly incorporated herein by reference. To the extent Kamalakaran may not teach non-aromatics (i.e. alkanes) as a hydrocarbon source, Ci teaches hexane (i.e. a 6 carbon alkane). (Ci at 797, col. 2). Ci uses hexane to grown nanotubes, i.e. they are art recognized equivalents. Substitution of one for the other does not impart patentability. Furthermore, Ci provides motivation to use hexane, for example the ability to "dissolve a catalyst (i.e., ferrocene) quite easily." *Id.*

Claims 1-5, 8, 10-17, 20-23, 28-31, and 43-44 rejected under 35 U.S.C. 103(a) as being unpatentable over Kamalakaran, et al., *Synthesis of thick and crystalline nanotube arrays by spray pyrolysis*, Applied Physics Letters 2000; 77(21): 3385-3387 as applied to claim 1 above, and further in view of Cassell, et al., *Large Scale CVD Synthesis of Single-Walled Carbon Nanotubes*, J. Phys. Chem. B 1999; 103: 6484-6492.

The preceding discussion accompanying the anticipation rejection over Kamalakaran is expressly incorporated herein by reference. To the extent Kamalakaran may not teach metal salts as a catalyst, the Examiner is taking official notice that the use of metal salts in nanotube synthesis is old and known. In support of taking official notice (i.e. in making sure there is substantial evidence on the record), the Examiner cites to Cassell. *See generally* (Cassell at 6485, col. 1) ("Catalyst Preparation"). Note that with respect to Claims 12-14, iron and nitrates are taught. *Id*. One would be motivated to employ metal salts as they afford the skilled artisan the ability to optimize the chemical composition of the catalyst, as taught and suggested by Cassell. (Cassell at 6492, col. 1).

Claims 1-5, 8, 10-12, 15-17, 20-31, and 43-44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kamalakaran, et al., *Synthesis of thick and crystalline nanotube arrays by spray pyrolysis*, Applied Physics Letters 2000; 77(21): 3385-3387 as applied to claim 1 above, and further in view of US 5,697,432 to Anderson, et al.

The preceding discussion accompanying the anticipation rejection over Kamalakaran is expressly incorporated herein by reference. To the extent Kamalakaran may not teach the "specific injection system" as claimed in claims 2-3, 24-26 and 43-44, Anderson discloses an injection system of the "automobile heat engine" type. *See* (Anderson 1: 59 *et seq.*). Note that Anderson recites a "needle valve." (Anderson "Abstract"). Kamalakaran teaches the size of the spray droplet *and flow rate* (among others), are important factor in the alignment and crystallinity of the nanotubes. (Kamalakaran at 3387, col. 1). Anderson discloses the ability to vary the amount of fuel and the time interval between injection, *i.e.* controlling flow rate. *See generally* (Anderson 14: 5 *et seq.*). One would be motivated to use the injection system of Anderson with the process of Kamalakaran due to the ability to control the amount of fuel/precursor introduced into the reactor.

Claims 1-5, 8, 10-12, 15-17, 20-23, 27-31, and 43-44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kamalakaran, et al., *Synthesis of thick and crystalline nanotube arrays by spray pyrolysis*, Applied Physics Letters 2000; 77(21): 3385-3387 as applied to claim 1 above, and further in view of WO 00/63115 to Dai, et al.

The preceding discussion accompanying the anticipation rejection over Kamalakaran is expressly incorporated herein by reference. To the extent Kamalakaran may not teach the two stage heating (evaporation followed by introduction into the reactor) as required by Claim 27, Dai does. *See* (Dai "Fig. 1"). Employing the two stage process of Dai would allowed the skilled artisan to "control the conditions of pyrolysis to obtain nanotubes having the desired characteristics. (Dai 4: 14).

Claims 1-5, 8, 10-12, 15-17, 20-23, and 28-44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kamalakaran, et al., *Synthesis of thick and crystalline nanotube arrays by spray pyrolysis*, Applied Physics Letters 2000; 77(21): 3385-3387 as applied to claim 1 above, and further in view of Li, et al., Structure and growth of aligned carbon nanotube films by pyrolysis, Chemical Physics Letters 2000; 316: 349-355 (hereinafter "Li, CPL at __"), Li, et al., Large-Scale Synthesis of Aligned Carbon Nanotubes, Science 1996; 274: 1701-1703 (hereinafter "Li, Science at __"), Smiljanic, et al., Growth of carbon nanotubes on Ohmically heated carbon paper, Chemical Physics Letters 2001; 342: 503-509 (hereinafter "Smiljanic at __"), and Zheng, et al., *Chemical Vapor Deposition Growth of Well-Aligned Carbon Nanotube Pattens on Cubic Mesoporous Silica Films by Soft Lithography*, Chem. Mater. 2001; 13: 2240-2242 (hereinafter "Zheng at __").

The preceding discussion accompanying the anticipation rejection over Kamalakaran is expressly incorporated herein by reference. With respect to Claims 32-42, to the extent Kamalakaran may not recite a substrate, the Examiner is taking official notice that growing nanotubes on a variety of substrates with a catalyst is old and known. In fact, it is quite common.

In support of taking official notice (i.e. in making sure there is substantial evidence on the record), the Examiner provides the following (with the caveat that *many more* references teaching a nanotube on a substrate could have been provided):

1. Li, et al., *Structure and growth of aligned carbon nanotube films by pyrolysis*, Chemical Physics Letters 2000; 316: 349-355.
2. Li, et al., *Large-Scale Synthesis of Aligned Carbon Nanotubes*, Science 1996; 274: 1701-1703.
3. Smiljanic, et al., *Growth of carbon nanotubes on Ohmically heated carbon paper*, Chemical Physics Letters 2001; 342: 503-509.
4. Zheng, et al., *Chemical Vapor Deposition Growth of Well-Aligned Carbon Nanotube Pattens on Cubic Mesoporous Silica Films by Soft Lithography*, Chem. Mater. 2001; 13: 2240-2242.

Note that Li – like Applicants - employs a pyrolysis technique. (Li, CPL at 350, col. 1). Also, note that Li employs quartz substrates, as claimed by Applicants. *Id.* To the extent that Li, CPL teaches introduction of the catalyst via a precursor (in the case of Li, iron (II) phthalocyanine) versus depositing the catalyst on a substrate – as claimed in Claim 33 - this embodiment is similarly old and known. Since at least the mid-1990s, skilled artisans have been depositing catalyst on substrates and growing nantoubes, *See* (Li, Science at 1702, col. 2; "Fig. 4"). Likewise, with respect to Claims 36 and 42 growing nanotubes on carbon fiber substrates is old an known. *See* (Smiljanic "Abstract"). (Note that claims 36 and 42 would read on nanotubes growing on top of other nanotubes in any nanotube growth process). The manner in which the catalyst can be deposited (Claims 37-41) is old and known, taught any number of places. For example, Zheng employs techniques to pattern catalysts on silica substrates. *See* (Zheng at 2241, "Figs. 1-2").

In sum, growing nanotubes with a catalyst on a substrate is hardly novel. One would be motivated to utilize a catalyst for any number of reasons – like the ability to place catalysts (and in turn nanotubes) in discrete locations with some precision as demonstrated by Zheng. Furthermore, employing a catalyst and substrate "shows fascinating possiblities for directed growth of CNTs that could be used for large area, low-cost, flexible electronic and photonic devices." (Zheng at 2242).

Claims 1-5, 9, 10-12, 15-17, 20-22, 27-31, and 43-44 rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Terrones, et al., *Novel nanoscale gas containers: encapsulation of* N_2 *in* CN_x *nanotubes*, Chem. Commun. 2000: 2335-2336.

The preceding discussion accompanying the anticipation rejection over Terrones is expressly incorporated herein by reference. See above with respect to 102/103 rejections.

Claims 1-7, 9, 10-12, 15-17, 20-22, 27-31, and 43-44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Terrones, et al., *Novel nanoscale gas containers: encapsulation of* N_2 *in* CN_x *nanotubes*, Chem. Commun. 2000: 2335-2336 as applied to claim 1 above, and further in view of Zhu, et al., *Direct Synthesis of Long Single-Walled Carbon Nanotube Strands*, Science 2002; 296: 284: 884-886.

The preceding discussion accompanying the anticipation rejection over Terrones is expressly incorporated herein by reference. To the extent Terrones may not teach non-aromatics (i.e. alkanes) as a hydrocarbon source, Zhu teaches hexane (i.e. a 6 carbon alkane). (Zhu at 884,

col. 1). Zhu uses hexane to grown nanotubes, i.e. they are art recognized equivalents. Substitution of one for the other does not impart patentability.

Claims 1-7, 9, 10-12, 15-17, 20-22, 27-31, and 43-44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Terrones, et al., *Novel nanoscale gas containers: encapsulation of N_2 in CN_x nanotubes*, Chem. Commun. 2000: 2335-2336 as applied to claim 1 above, and further in view of Ci, et al., *Preparation of carbon nanotubules by the floating catalyst method*, J. Mater. Sci. Ltrs. 1999; 18: 797-799.

The preceding discussion accompanying the anticipation rejection over Terrones is expressly incorporated herein by reference. To the extent Terrones may not teach non-aromatics (i.e. alkanes) as a hydrocarbon source, Ci teaches hexane (i.e. a 6 carbon alkane). (Ci at 797, col. 2). Ci uses hexane to grown nanotubes, i.e. they are art recognized equivalents. Substitution of one for the other does not impart patentability. Furthermore, Ci provides motivation to use hexane, for example the ability to "dissolve a catalyst (i.e., ferrocene) quite easily." *Id.*

Claims 1-5, 9, 10-17, 20-22, 27-31, and 43-44 rejected under 35 U.S.C. 103(a) as being unpatentable over Terrones, et al., *Novel nanoscale gas containers: encapsulation of N_2 in CN_x nanotubes*, Chem. Commun. 2000: 2335-2336 as applied to claim 1 above, and further in view of Cassell, et al., *Large Scale CVD Synthesis of Single-Walled Carbon Nanotubes*, J. Phys. Chem. B 1999; 103: 6484-6492.

The preceding discussion accompanying the anticipation rejection over Terrones is expressly incorporated herein by reference. To the extent Terrones may not teach metal salts as a

catalyst, the Examiner is taking official notice that the use of metal salts in nanotube synthesis is old and known. In support of taking official notice (i.e. in making sure there is substantial evidence on the record), the Examiner cites to Cassell. *See generally* (Cassell at 6485, col. 1) ("Catalyst Preparation"). Note that with respect to Claims 12-14, iron and nitrates are taught. *Id.* One would be motivated to employ metal salts as they afford the skilled artisan the ability to optimize the chemical composition of the catalyst, as taught and suggested by Cassell. (Cassell at 6492, col. 1).

Claims 1-5, 9-12, 15-17, 20-31, and 43-44 rejected under 35 U.S.C. 103(a) as being unpatentable over Terrones, et al., *Novel nanoscale gas containers: encapsulation of N_2 in CN_x nanotubes*, Chem. Commun. 2000: 2335-2336 as applied to claim 1 above, and further in view of US 5,697,432 to Anderson, et al..

The preceding discussion accompanying the anticipation rejection over Terrones is expressly incorporated herein by reference. To the extent Terrones may not teach the "specific injection system" as claimed in claims 2-3, 24-26 and 43-44, Anderson discloses an injection system of the "automobile heat engine" type. *See* (Anderson 1: 59 *et seq.*). Note that Anderson recites a "needle valve." (Anderson "Abstract"). Terrones teaches that a spraying technique is desirable. (Terrones at 2335, col. 1). Anderson discloses the ability to control spraying. *See generally* (Anderson 14: 5 *et seq.*). One would be motivated to use the injection system of Anderson with the process of Terrones due to the ability to control the amount of fuel/precursor introduced into the reactor.

Claims 1-5, 9-12, 15-17, 20-22, 27-31, and 43-44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Terrones, et al., *Novel nanoscale gas containers: encapsulation of N_2 in CN_x nanotubes*, Chem. Commun. 2000: 2335-2336 as applied to claim 1 above, and further in view of WO 00/63115 to Dai, et al.

The preceding discussion accompanying the anticipation rejection over Terrones is expressly incorporated herein by reference. To the extent Terrones may not teach the two stage heating (evaporation followed by introduction into the reactor) as required by Claim 27, Dai does. *See* (Dai "Fig. 1"). Employing the two stage process of Dai would allowed the skilled artisan to "control the conditions of pyrolysis to obtain nanotubes having the desired characteristics. (Dai 4: 14).

Claims 1-5, 9-12, 15-17, 20-22, 27-44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Terrones, et al., *Novel nanoscale gas containers: encapsulation of N_2 in CN_x nanotubes*, Chem. Commun. 2000: 2335-2336 as applied to claim 1 above, and further in view of Li, et al., Structure and growth of aligned carbon nanotube films by pyrolysis, Chemical Physics Letters 2000; 316: 349-355 (hereinafter "Li, CPL at __"), Li, et al., Large-Scale Synthesis of Aligned Carbon Nanotubes, Science 1996; 274: 1701-1703 (hereinafter "Li, Science at __"), Smiljanic, et al., Growth of carbon nanotubes on Ohmically heated carbon paper, Chemical Physics Letters 2001; 342: 503-509 (hereinafter "Smiljanic at __"), and Zheng, et al., *Chemical Vapor Deposition Growth of Well-Aligned Carbon Nanotube Pattens on Cubic Mesoporous Silica Films by Soft Lithography*, Chem. Mater. 2001; 13: 2240-2242 (hereinafter "Zheng at __").

The preceding discussion accompanying the anticipation rejection over Terrones is expressly incorporated herein by reference. With respect to Claims 32-42, to the extent Terrones may not recite a substrate, the Examiner is taking official notice that growing nanotubes on a variety of substrates with a catalyst is old and known. In fact, it is quite common. In support of taking official notice (i.e. in making sure there is substantial evidence on the record), the Examiner provides the following (with the caveat that *many more* references teaching a nanotube on a substrate could have been provided):

1. Li, et al., *Structure and growth of aligned carbon nanotube films by pyrolysis*, Chemical Physics Letters 2000; 316: 349-355.
2. Li, et al., *Large-Scale Synthesis of Aligned Carbon Nanotubes*, Science 1996; 274: 1701-1703.
3. Smiljanic, et al., *Growth of carbon nanotubes on Ohmically heated carbon paper*, Chemical Physics Letters 2001; 342: 503-509.
4. Zheng, et al., *Chemical Vapor Deposition Growth of Well-Aligned Carbon Nanotube Pattens on Cubic Mesoporous Silica Films by Soft Lithography*, Chem. Mater. 2001; 13: 2240-2242.

Note that Li – like Applicants - employs a pyrolysis technique. (Li, CPL at 350, col. 1). Also, note that Li employs quartz substrates, as claimed by Applicants. *Id.* To the extent that Li, CPL teaches introduction of the catalyst via a precursor (in the case of Li, iron (II) phthalocyanine) versus depositing the catalyst on a substrate – as claimed in Claim 33 - this embodiment is similarly old and known. Since at least the mid-1990s, skilled artisans have been depositing catalyst on substrates and growing nantoubes, *See* (Li, Science at 1702, col. 2; "Fig. 4"). Likewise, with respect to Claims 36 and 42 growing nanotubes on carbon fiber substrates is old an known. *See* (Smiljanic "Abstract"). (Note that claims 36 and 42 would read on nanotubes growing on top of other nanotubes in any nanotube growth process). The manner in which the

catalyst can be deposited (Claims 37-41) is old and known, taught any number of places. For example, Zheng employs techniques to pattern catalysts on silica substrates. *See* (Zheng at 2241, "Figs. 1-2").

In sum, growing nanotubes with a catalyst on a substrate is hardly novel. One would be motivated to utilize a catalyst for any number of reasons – like the ability to place catalysts (and in turn nanotubes) in discrete locations with some precision as demonstrated by Zheng. Furthermore, employing a catalyst and substrate "shows fascinating possiblities for directed growth of CNTs that could be used for large area, low-cost, flexible electronic and photonic devices." (Zheng at 2242).

Conclusion

Nanotubes from CVD/pyrolysis are old and known. Many more rejections could have been crafted, but were considered cumulative to those of record.

All amendments made in response to this Office Action must be accompanied by a pinpoint citation to the Specification (i.e. page and paragraph or line number) to indicate where Applicants are drawing their support.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Daniel C. McCracken whose telephone number is (571) 272-6537. The examiner can normally be reached on Monday through Friday, 9 AM - 6 PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Stanley S. Silverman can be reached on (571) 272-1358. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Daniel C. McCracken/

Daniel C. McCracken
Examiner, Art Unit 1793
DCM

/Stuart Hendrickson/

Stuart L. Hendrickson
Primary Examiner